Southern Forest Experiment Station

SO-229

Research Note

1977

Cottonwood Response To Nitrogen Related To Plantation Age and Site

B. G. BLACKMON

SUMMARY

When applied at plantation age 4, 336 kg N/ha increased diameter growth of cottonwood on Sharkey clay by 33 percent over unfertilized controls. Fertilizing at ages 2 and 3 resulted in no response, nor was there any benefit from applying nitrogen fertilizer to cottonwood on Commerce silt loam. On both sites, foliar N levels were increased by fertilization regardless of plantation age.

Additional keywords: Fertilization, *Populus deltoides* Bartr., growth, foliar N, rooting depth.

PROBLEM

Nitrogen deficiency can be a serious problem on medium-textured old-field soils in the Mississippi River floodplain (Blackmon and Broadfoot 1969, Blackmon and White 1972). Large responses to fertilization are now being measured on Commerce soils, when much of their indigenous soil nitrogen has been depleted.

The present study was installed primarily to determine if applying high rates of nitrogen would improve the growth of eastern cottonwood *(Populus deltoides* Bartr.) on a recently sheared Commerce silt loam and on an old-field Sharkey clay. The study also allowed an investigation of the relationship between plantation age and responses to nitrogen.

METHODS

Plantations were established in 1967, 1968, and 1969 on Commerce silt loam (Aeric Fluvaquent) which recently had been sheared of timber and on Sharkey clay (Vertic Haplaquept) which previously had been in agriculture. Both soils developed from Mississippi River alluvium. Plantings originally were made at about 3 X 3-meter spacing. In the fall of 1970, every other row was removed, leaving a spacing of 3 X 6 meters.

Average tree heights and diameters at the time of fertilization were as follows:

Southern Forest Experiment Station/T-10210 U.S. Postal Services Bldg., 701 Loyola Avenue, New Orleans, La. 70113
Forest Service, U.S. Department of Agriculture.
Serving Alabama, Arkansas, Louisiana, Mississippi, Eastern Oklahoma, Tennessee, Eastern Texas.

Age	Sharkey clay		Commerce silt loam	
	Height (m)	DBH (cm)	Height (m)	DBH (cm)
2	3.3	2.8	6.3	7.4
3	5.3	5.6	11.8	10.7
4	6.8	7.9	13.6	12.4

Ammonium nitrate fertilizer at 0, 336, and 672 kilograms of nitrogen per hectare was broadcast onto the soil surface in April 1971. The study areas, including controls, were disked immediately following treatment and maintained free of herbaceous vegetation by disking during the first season after treatment. The study was replicated two times on each site in a split-plot experimental design. Plantation age constituted major plots, and rates of N, subplots. Each subplot contained 15 trees and occupied 0.024 hectare.

DBH and total heights were measured at the end of the 1971 growing season. Foliage samples were taken from the mid-crown position in August of 1971, dried at 70° C, ground, and analyzed for N by the macro-Kjeldahl procedure.

DBH and height growth and foliar N were studied by analysis of variance and Duncan's new multiple range test at the 0.05 level of probability. The study was designed, installed, and recorded in English measure, but the results are reported here in metric equivalents.

RESULTS AND DISCUSSION

Nitrogen fertilizer significantly influenced diameter growth of 4-year-old trees on the Sharkey clay soil (fig. 1). Trees treated with 336 and 672 kg of N/ha grew 24 mm and 21 mm respectively, compared to 18 mm for the control. However, the 672-kg treatment was not significantly different from the control. When done at ages 2 and 3, fertilization had no significant influence on growth. Even though the trees treated at age 4 with 336 kg of N/ha were 65% taller than the controls, height growth differences were not significantly different. Neither height nor diameter responded to fertilization on the Commerce silt loam soil.

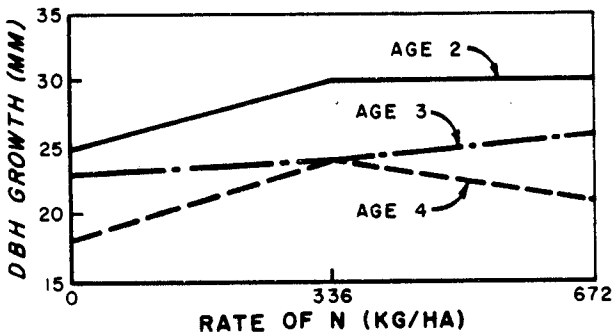

Figure 1.—*Effect of nitrogen fertilization on dbh growth of eastern cottonwood on Sharkey clay (applied at ages 2, 3, and 4).*

The actual growth responses for cottonwood on Sharkey clay were very small — 33% more dbh growth than the unfertilized controls. However, these results do indicate an important relationship between stand age and response to added nutrients. No response to treatment at age 2 and 3 probably indicates that the young trees' root systems lacked sufficient development to take advantage of the added nitrogen. Also, at these ages competition among trees was not significant, and the nitrogen demands were apparently met by indigenous soil nitrogen. But a slight response to N fertilization occurred in the 4-year-old plantation after the trees developed larger root systems and the trees began to compete for nutrients. Similar trends have been reported for irrigation responses (Rawitz, Karschon, and Mitrani 1966).

Both Sharkey clay and Commerce silt loam soils generally contain levels of soil nitrogen adequate for good cottonwood growth. However, because of poor physical conditions in Sharkey, most of the roots are confined to the upper 20 cm (Baker and Blackmon--In press). Root development is restricted and the trees are not able to extract sufficient soil nitrogen. Since rooting is usually deeper in Commerce, a greater soil volume is exploited. Thus the tree is able to meet its needs for nitrogen, and fertilization usually is not required.

On both sites fertilization significantly increased foliar N concentrations (table 1). On the clay soil fertilizer increased foliar N from 1.7% to 2.1%. On the silt loam site, foliar N was increased from 2.0% to 2.4%. Foliar N was not related to stand age on either site, nor was there a difference between the 336- and 672-kg rates.

Earlier results have shown the critical foliar N level to be about 2% for cottonwood (White and Carter 1970, Blackmon and White 1972).

B. G. Blackmon is Principal Soil Scientist at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Miss., by the Southern Forest Experiment Station, Forest Service—USDA, in cooperation with the Mississippi Agricultural and Forestry Experiment Station and the Southern Hardwood Forest Research Group.

Table 1.—*Effect of nitrogen fertilization on foliar N levels in cottonwood (averaged over all three ages)*

Rate of nitrogen	Foliar nitrogen	
	Sharkey clay	Commerce silt loam
-kg/ha-	*----------percent----------*	
0	1.7a [1]	2.0a
336	2.1 b	2.4 b
672	2.1 b	2.4 b

[1] Means followed by the same letter are not significantly different by Duncan's new multiple range test (.05 level).

In the present study a growth response occurred on the clay site when foliar N levels (averaged over all ages) were increased from 1.7% to slightly above 2%. In the 4-year-old stand — the one in which the growth response was observed — control trees averaged only 1.5% foliar N. On the silt loam soil, foliar N was increased; however, N in the controls was at 2.0%, which apparently was not a deficiency level since no response occurred.

CONCLUSIONS

Even though the growth response was small, this study indicates that response to broadcast applications of N fertilizer is not likely to occur in widely spaced plantations until the site becomes fully occupied and competition for nutrients is established. Such a delayed response appeared to occur at age 4 on the Sharkey clay soil in this experiment.

The study also indicates that cottonwood growing on recently sheared, highly productive soils such as Commerce silt loam is not likely to respond even to high rates of N.

Finally, this study supports the thesis that a foliar N level of less than 2% represents a deficiency level for eastern cottonwood.

LITERATURE CITED

Baker, James B., and B. G. Blackmon.
(In press.) Biomass and nutrient accumulation in a cottonwood plantation — The first growing season. Soil Sci. Soc. Am. J.

Blackmon, B. G., and W. M. Broadfoot.
1969. Lime, fertilizer cottonwood tests. Miss. Farm Res. 32(7): 6,8.

Blackmon, B. G., and E. H. White.
1972. Nitrogen fertilization increases cottonwood growth on old-field soil. USDA For. Serv. Res. Note SO-143, 5 p., South. For. Exp. Stn., New Orleans, La.

Rawitz, E., R. Karschon, and K. Mitrani.
1966. Growth and consumptive water use of two poplar clones under different irrigation regimes. Isr. J. Agric. Res. 16(2): 77-78.

White, E. H., and M. C. Carter.
1970. Relationships between foliar nutrient levels and growth of young natural stands of *Populus deltoides* Bartr. P. 283-294 *in* Chester T. Youngberg and Charles B. Davey, eds. Tree growth and forest soils. Third N. Am. For. Soils Conf. Proc. 1968. Oregon State Univ. Press. Corvallis. Oregon.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1977—774-960